
EXECUTIVE SUMMARY

The Accident

On October 11, 2004, at approximately 11:15 am, a subcontractor electrician working at the Stanford Linear Accelerator Center (SLAC) received serious burn injuries requiring hospitalization due to an electrical arc flash that occurred during the installation of a circuit breaker in an energized 480-Volt (V) electrical panel.

On October 15, 2004, the Acting Assistant Secretary for the U.S. Department of Energy (DOE) Office of Environment, Safety and Health appointed a Type A Accident Investigation Board (the Board) to investigate the accident in accordance with DOE Order 225.1A, *Accident Investigations*.

Analysis and Results

The accident resulted from deficiencies in SLAC's work control planning and implementation processes. The Site Engineering and Maintenance Department (SE&M) exhibits a culture where safety is often secondary to operations. The Board identified deficiencies in the line management organizations of the DOE Stanford Site Office (SSO), SLAC, and Bay Span, Inc. (Bay Span), the electrical subcontractor performing the work.

The events leading up to and during the installation of the circuit breaker and the resultant arc flash are characteristic of an unstructured and largely undocumented approach to work that does not ensure the safety and health of workers at SLAC. Managers, supervisors, and support staff do not take action to enforce compliance with the safety requirements for this very dangerous task. For the circuit breaker replacement, the Board identified the following key deficiencies:

- A "Pre-Work Hazard Analysis" (PWA) form was not completed.
- There was no approved electrical hot work permit.
- The workers were not wearing the appropriate Flame Resistant (FR) clothing and all the required Personal Protective Equipment (PPE).

- The Bay Span Laborer (BSL) was not trained to be backup for an electrician.
- No one in the SLAC management chain had been informed of the decision by the SLAC Field Supervisor (FS-1) to install the circuit breaker in an energized panel.
- SLAC safety officials were not involved (only notified after such work occurred).

All SLAC management officials above FS-1 stated that it was unnecessary for the circuit breaker installation to be done with the panel energized, and they would not have approved working on an energized circuit breaker panel. The events that occurred on October 11, 2004, violated all of the Integrated Safety Management (ISM) Guiding Principles and Core Functions.

As recently as July 23, 2004, SLAC management prepared a report to the DOE Office of Science in which work on energized electrical equipment performed at SLAC was reviewed. On June 24, 2004, the SLAC Director formed an Electrical Safety Review Team to focus on areas of concern identified by DOE: (1) personnel errors, (2) work control problems, (3) configuration management weaknesses, (4) electrical intrusion events, and (5) vehicles. The review team's report analyzed 31 SLAC electrical hot work permits from February 25, 2004, through May 25, 2004, and found that 23 did not have the necessary justification for the work to be conducted while systems were energized. Nineteen of the hot work permits were missing some of the required information. This report also notes significant deficiencies in each area reviewed. As significant as the findings were, the review team, SLAC management, and SSO did not demonstrate a sense of urgency in implementing the recommendations that resulted from the review.

The significant breakdown in the enforcement of health and safety requirements is indicative of a work environment where occupational safety and health policies, programs, and procedures for worker protection are not fully implemented. The SE&M, in particular, has not balanced the priorities of accelerator operations and worker protection.

Conclusion

The Board concludes that this accident was preventable. The direct cause of the injury was an explosive release of energy resulting from an arc flash that occurred during the installation of a circuit breaker in a 480V energized panel. The circuit breaker installation on an energized panel was not justified. If proper permitting procedures had been followed, the work would not have been performed. The severity of the injuries could have been significantly reduced or eliminated had the worker been wearing the appropriate FR clothing and using the correct PPE. There were at least three people directly involved in the task with sufficient direct interaction and safety knowledge who could have exercised stop work authority because of the unsafe working conditions, yet no one took action.

The SLAC managers above FS-1 (the SE&M line managers responsible for the work in the area where the accident occurred) were not involved in work planning, task monitoring, or follow-up to ensure that the principles of ISM were applied. FS-1 stated that assignments associated with this work were verbal and that such informality was characteristic of the SE&M's work practices. SE&M management assigned FS-1 to function as

a University Technical Representative (UTR), although he has not received the required training. UTRs manage the subcontractor.

FS-1 was not in the immediate area when the arc flash occurred; there was no site supervision by SLAC over this hazardous job. Personnel from the Environment, Safety, and Health (ES&H) Division were not present, as this organization monitors work on a random basis. Consequently, there was no SLAC safety professional involvement with this event. Interviews with other SLAC employees and managers indicated that this approach to work is prevalent in the SE&M. Bay Span, the subcontractor, provided no oversight. The injured Bay Span foreman was not wearing clothing or PPE appropriate for electrical work at the time of the accident.

The DOE SSO put safety and health performance criteria in the SLAC contract in response to previous safety problems. The thrust of the performance criteria is the full implementation of the ISM System. This investigation determined that violations of all seven ISM Guiding Principles and all five ISM Core Functions led to this accident. Table ES-1 identifies the Board's conclusions and the resulting Judgments of Need.

Table ES-1. Conclusions and Judgments of Need

Conclusions	Judgments of Need
<p>There was no justification for installing the breaker in energized Panel 4P20R.</p> <p>Neither SLAC nor Bay Span fulfilled Title 29 Code of Federal Regulations (CFR), Part 1910.132 hazard assessment requirements for the breaker installation being attempted at the time of the accident.</p> <p>SE&M's and Bay Span's practices regarding working on or near energized electrical equipment violated the provisions of 29 CFR 1910.333(a)(1).</p> <p>Neither SE&M nor Bay Span management ensured that the Bay Span Electrician (BSE)-1, BSE-2, or BSL used electrical protective equipment appropriate for the specific parts of the body to be protected from arc flash hazards. This failure violated the provisions of 29 CFR 1910.335(a)(1)(i).</p> <p>BSE-1 meets 29 CFR 1910.332(b)(3) training requirements to be a "qualified person." Based on BSL's testimony, BSL is an "unqualified person."</p> <p>Given SE&M's and Bay Span's decision to install the circuit breaker with Panel 4P20R energized, they failed to identify other safety-related work practices (such as those included NFPA 70E) to protect the employees who were exposed to the electrical hazards involved. This failure violated the provisions of 29 CFR 1910.333(a)(2).</p> <p>The breaker installation that FS-1 directed BSE-1 to accomplish was work covered under 29 CFR 1910.331(a). In that context, BSE-1 was a qualified person and BSL was an unqualified person.</p> <p>The tool BSE-1 used at the time of the accident violated 29 CFR 1910.335(a)(2)(i) because the screwdriver being used at the time was not insulated.</p> <p>When an installation problem developed, BSE-1's options for diagnosing the problem were limited by the fact that the panel was energized.</p>	<p>JON 1: SLAC needs to enforce applicable Occupational Safety and Health Administration (OSHA) standards and all sections of National Fire Protection Association (NFPA) Standard 70E.</p> <p>JON 2: SLAC needs to ensure that SLAC's employees who work on or near exposed energized electrical conductors are trained on the implementation of electrical safety-related work practices.</p> <p>JON 3: SLAC needs to verify that subcontractor employees who work on or near exposed energized electrical conductors are trained on the implementation of electrical safety-related work practices.</p> <p>JON 4: SLAC and subcontractor supervisors and managers need to receive the same training as the workers.</p>
<p>Despite receipt of the lowered annual assessment rating and SSO's interaction with the SLAC ES&H Department and Director, SLAC has not responded with implementation of sound work planning and hazard control processes. SSO has not been effective in creating a "safety first" approach within SLAC.</p>	<p>JON 5: SSO needs to exercise the existing SLAC contract clauses, terms, and conditions that hold SLAC accountable for unacceptable safety performance, including stop work authority or the embargo of funds until SLAC demonstrates satisfactory electrical safety performance.</p>
<p>SLAC's policies, procedures, and contracting practices regarding subcontractor worker protection are not consistent with the OSHA safety electrical standards.</p>	<p>JON 6: SSO needs to ensure that legal interpretations by SLAC to establish each employer's worker protection responsibilities are consistent with OSHA's interpretations on multiemployer workplaces.</p>

Conclusions	Judgments of Need
<p>Since the Bay Span workers' tenure at SLAC is closely tied to satisfying the UTR, a situation exists where workers might willingly take risks in order to demonstrate productivity and thus continue to work at the high wages.</p> <p>Bay Span employees BSE-1, BSE-2, and BSL contributed to this accident by failing to follow NFPA 70E, the terms of the Bay Span subcontract, and the guidance contained in the Bay Span employee handbook.</p> <p>Because FS-1 met with BSE-1 to give him verbal instruction to perform the hot work, FS-1 was aware of the way BSE-1 was dressed. FS-1 failed to enforce the SLAC's contract requirements, and he failed to implement the SLAC/Bay Span safety processes (i.e., a PWH and an approved hot work permit).</p>	<p>JON 7: SLAC needs to revise the contracting process to ensure that subcontractor workers can protect themselves from SLAC-related hazards in the same way that SLAC workers protect themselves. The terms and conditions of subcontracts should not encourage workers to take risks.</p>
<p>Documented safety processes are not effectively implemented.</p> <p>Unsafe conditions and operations have become accepted as a part of the everyday way of doing business.</p> <p>Problems with electrical safety, particularly electrical hot work, are known within the ES&H and SE&M organizations.</p> <p>The SLAC line organizations have been resistant to safety oversight, which should have elevated electrical safety work practice deficiencies to SLAC management's attention for correction.</p> <p>The work being done at the time of the accident violated every ISM Core Function and every ISM Guiding Principle. It also failed to provide worker protection in accordance with NFPA 70E.</p>	<p>JON 8: The SLAC Director needs to balance the priorities between operations and safety to:</p> <ul style="list-style-type: none"> ▪ Evaluate whether it is appropriate for the Technical Division to be responsible for scheduling Linear Accelerator (LINAC) operations and safely maintaining the LINAC infrastructure. ▪ Achieve effective, proactive ES&H Division involvement. ▪ Encourage SE&M employees to work safely and to exercise their stop work authority.
<p>Within SE&M, the ISM Core Functions and Guiding Principles are not being followed and have effectively no impact because operations are placed above safety concerns.</p> <p>Problems with electrical safety, particularly electrical hot work, are known within the ES&H and SE&M organizations.</p> <p>The <i>Electrical Safety Action Plan, Stanford Linear Accelerator Center</i> identifies many of the same deficiencies identified in this investigation report.</p>	<p>JON 9: SLAC needs to develop and implement safety oversight programs designed to identify deficient electrical work practices and correct them in a timely manner that achieves continuous improvement.</p>
<p>The <i>Electrical Safety Action Plan, Stanford Linear Accelerator Center</i> identifies many of the same deficiencies identified in this investigation report.</p>	<p>JON 10: SSO needs to develop and implement safety oversight programs designed to identify deficient electrical work practices and correct them in a timely manner that achieves continuous improvement.</p>
<p>SLAC's emphasis on the scientific mission as a means to secure funding from the Office of Science and compete with other laboratories reached FS-1's level as direction to "just get the job done."</p>	<p>JON 11: The SLAC Director needs to ensure that employees at all levels fully understand that concern for mission accomplishment does not outweigh the need for safe operations.</p>

Conclusions	Judgments of Need
SSO has not filled an existing vacant safety and health position. SSO could make more effective use of Oak Ridge Operations Office support.	JON 12: SSO needs to do a workload study to determine the resource level and skills mix necessary to fulfill their safety responsibilities.
SLAC's site readiness to prepare for a DOE accident investigation has improved.	No action required.
The emergency medical response was timely and well managed.	No action required.